

**New York University Tandon School of Engineering**  
**Department of Computer Science & Engineering**

CS3224  
Operating Systems Design and  
Implementation

Spring 2020  
Professor Sandoval

Contact`

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My background is [here](#).

Jay Street Building, Office 846

Office hours: tbd

- If these times don't work for you, email me and we can set up a time to meet.

Student Assistants & Office Hours:

Course Pre-requisites

CS-UY 2214 (Computer Architecture and Organization)

CS-UY 2134 (Data Structures and Algorithms)

**Strong Programming in C or C++.** (You will have a very hard time, and are at risk of failing the class if you haven't programmed in C or C++ before)

Course Description

This course is an introduction to operating system design and implementation. We study operating systems because they are examples of mature and elegant solutions to a difficult design problem: how to safely and efficiently share system resources and provide abstractions useful to applications.

For the processor, memory, and disks, we discuss how the operating system allocates each resource and explore the design and implementation of related abstractions.

We also establish techniques for testing and improving system performance and introduce the idea of hardware virtualization. Programming assignments provide hands-on experience with implementing core operating system components in a realistic development environment. We will examine in detail the design and

implementation of a UNIX-like operating system, and cover general operating systems concepts, such as processes, threads, device drivers, filesystems, scheduling, and concurrency.

## Readings

### Textbooks:

- Arpaci-Dusseau, R and Arpaci-Dusseau A. **Operating Systems Three Easy Pieces**. Available [online](#) for free.
- Russ Cox, Frans Kaashoek, and Robert Morris, **xv6: A simple, Unix-like teaching operating system**. <http://pdos.csail.mit.edu/6.828/2014/xv6/book-rev8.pdf>
- Andrew S. Tannenbaum, **Modern Operating Systems**. Available on NYU Classes.

### Useful references:

- Linux command line cheat sheet:  
[http://cli.learncodethehardway.org/bash\\_cheat\\_sheet.pdf](http://cli.learncodethehardway.org/bash_cheat_sheet.pdf)
- Gdb cheat sheet:  
<http://darkdust.net/files/GDB%20Cheat%20Sheet.pdf>

## Course requirements

- Attendance will not be taken, but it is highly recommended and it will help with your participation.
- Assignments must be received by midnight on the day they are due. Late homework will not be accepted.

## Cooperation Policy

You will work individually on every assignment. You may discuss solutions with your classmates but stop short of sharing your code with them.

## Academic Honesty

All work submitted in this course must be your own. Cheating and plagiarism will not be tolerated. If you have any questions about a specific case, *please ask me*.

NYU Poly's Policy on Academic Misconduct:

<http://engineering.nyu.edu/academics/code-of-conduct/academic-misconduct>

Course schedule (Tentative)

The course schedule is tentative, it's likely to change as the weeks go on.

In the following, OSTEP stands for **OSTEP** stands for **Operating Systems Three Easy Pieces**, MOS stands for **“Modern Operating Systems”**, xv6 stands for **“xv6: A simple, Unix-like teaching operating system”**

Week	Theme	Topic	Assignment	Reading
1 – Jan 28	<b>Introductory Topics</b>	Course Information. OS Intro.	HW1 out - intro	OSTEP 1 xv6 0-1
1 – Jan 30		C Programming Review		
2 – Feb 4		OS Overview		MOS 1 & xv6 0-1
2 – Feb 6		PC Hardware & Assembly Language	HW2 out-Assembly	MOS 1 & xv6 0-1
3 – Feb 11		PC Hardware & Assembly Language		MOS 1 & xv6 0-1
3 – Feb 13		The Boot Process		xv6 Appendix B
4 – Feb 18		System Call Interface	HW3 out – System Calls	xv6 Appendix B
4 – Feb 20		Processes		OSTEP 4, MOS 2 & xv6 5
5 – Feb 25		Process API		OSTEP 5, MOS 2 & xv6 5
5 - Feb 27		Scheduling Algorithms	Midterm Review	OSTEP 7, MOS 2 & xv6 5
6 – Mar 3		Midterm Review		
<b>6 – Mar 5</b>		<b>Midterm 1</b>		
7 – Mar 10	<b>Memory Virtualization</b>	Memory Management		MOS 3.3-3.5 & xv6 2
7 – Mar 12		Memory Management	HW5 out – Memory Management	MOS 3.3-3.5 & xv6 2
8 – Mar17 8 – Mar 19		<b>Spring Break</b>		

9 – Mar 24		Virtual Memory		MOS 3.3-3.5 & xv6 2
9 – Mar 26		Virtual Memory		MOS 3.3-3.5 & xv6 2
10 – Mar 31		Virtual Memory	Midterm Review	MOS 3.3-3.5 & xv6 2
10 – Apr 2	<b>Concurrency</b>	Threads April 3 Last day to withdraw from a class with a “W” grade		MOS 3.1-3.2 & xv6 2
11 – Apr 7		Concurrency	HW4 out - Concurrency	MOS 2.3 – 2.5
11 – Apr 9		Concurrency		MOS 2.3 – 2.5
12 – Apr 14		Midterm Review		
12 – Apr 16		Midterm 2		
13 – Apr 21	<b>Persistence</b>	Storage & Filesystems	HW 6 out - FileSystem	MOS 4.1-4.4 & xv6 6
13 – Apr 23		Storage & Filesystems		MOS 4.1-4.4 & xv6 6
14 – Apr 28		Device Drivers, Interrupts, and I/O	Extra Credit out	MOS 5 & xv6 3
14 – Apr 30		Security		MOS 9
15 – May 5	<b>Advanced Topics</b>	Virtualization		MOS 7
15 – May 7		Final Exam Review		
May 13 - 19		<b>Final Exam</b> (Final date is decided <b>schoolwide</b> and assigned to each class, so please don't make travel plans before the end of the week.		

Grading

Grading will be based on the following weights.

20% Homework (Programming Projects)

25% Midterm 1

25% Midterm 2

25% Final

5% Participation

Grading Schema:

A	92
A-	89
B+	86
B	83
B-	80
C+	75
C	70
C-	65
D+	60
D	51
F	0

Other Grading notes:

Please take the following into consideration during and after the semester and save yourself one or many emails.

- 1) **I must grade every student EXACTLY the same way.** To this end, I cannot give you special consideration as a result of your academic status (probation or otherwise), scholarships, work status, family situation, visa status, race, color, creed, religious beliefs, past alien abductions, current moon cycle, location of the sun in the sky or anything other than your academic performance. **Your grade must be based on your academic performance in my class.**

- 2) **I cannot change your grade simply because you ask me to.** Your grade is calculated based on your performance from the first day of class to moment you turn in the final exam.
- 3) **I will not give you additional work.** Please remember that I must treat all students the same, so if I give you additional work, I would have to give it to the entire class. This is unfair to the students who complete their work on time.
- 4) **Your grade is a measure of your performance in my class.** If you receive an “F” it is because you have demonstrated that you do not understand the material in the course; if you receive an “A” it is because you have demonstrated that you fully understand the material covered in the course. Other grades are assigned accordingly.

### **Moses Center Statement of Disability**

If you are student with a disability who is requesting accommodations, please contact New York University’s Moses Center for Students with Disabilities (CSD) at [212-998-4980](tel:212-998-4980) or [mosecsd@nyu.edu](mailto:mosecsd@nyu.edu). You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at [www.nyu.edu/csd](http://www.nyu.edu/csd). The Moses Center is located at 726 Broadway on the 3rd floor.

### **NYU School of Engineering Policies and Procedures on Academic Misconduct – complete Student Code of Conduct [here](#)**

- A. Introduction: The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who breach the School’s rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School’s Policy on Academic Misconduct.
- B. Definition: Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other

students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:

1. Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person's work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.
2. Fabrication: including but not limited to, falsifying experimental data and/or citations.
3. Plagiarism: intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.
4. Unauthorized collaboration: working together on work meant to be done individually.
5. Duplicating work: presenting for grading the same work for more than one project or in more than one class, unless express and prior permission has been received from the course instructor(s) or research adviser involved.
6. Forgery: altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.

**NYU School of Engineering Policies and Procedures on Excused Absences – complete policy [here](#)**

- A. Introduction: An absence can be excused if you have missed no more than **10 days of school**. If an illness or special circumstance has caused you to miss more than two weeks of school, please refer to the section labeled Medical Leave of Absence.
- B. Students may request special accommodations for an absence to be excused in the following cases:
  1. Medical reasons
  2. Death in immediate family
  3. Personal qualified emergencies (documentation must be provided)
  4. Religious Expression or Practice

Deanna Rayment, [deanna.rayment@nyu.edu](mailto:deanna.rayment@nyu.edu), is the *Coordinator of Student Advocacy, Compliance and Student Affairs* and handles excused absences. She is located in 5 MTC, LC240C and can assist you should it become necessary.

**NYU School of Engineering Academic Calendar – complete list [here](#).**

The last day of the final exam period is **May 19**\_\_\_\_. Final exam dates for undergraduate courses will not be determined until later in the semester.

Also, please pay attention to notable dates such as Add/Drop, Withdrawal, etc. For confirmation of dates or further information, please contact Susana: [sgarcia@nyu.edu](mailto:sgarcia@nyu.edu)